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THE PLANT DISEASE SURVEY

DIVISION OF MYCOLOGY AND DISEASE SURVEY

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RESULTS OF THE SURVEY FOR STINKING SMUT OF WHEAT IN 1931

Compiled by J. F. Faris*

For several years the causes of the excessive losses in stinking smut in the spring wheat States of Montana, North Dakota, South Dakota, and Minnesota have been under investigation by the various State experiment stations in the United States Department of Agriculture, in cooperation with the Northwest Crop Improvement Association and other agencies. An intensive campaign for seed treatment was carried out in several counties and the results of this campaign checked up in the following crop. In 1931 a survey was made in these four States to include not only the counties in which work had been done previously but to secure information from additional counties where the seed treatment has not been so strongly emphasized. The counties surveyed are shown on the map in figure 2.

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*This survey was conducted by the Plant Disease Survey, cooperating with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Dr. R. J. Haskell, extension plant pathologist, U. S. Department of Agriculture, and various State officials in the respective States as follows: Nebraska, Dr. G. L. Peltier, plant pathologist, P. H. Stewart and D. L. Gross, extension agronomists; South Dakota, E. A. Walker, Department of Plant Pathology, and Mr. H. R. Sumner, Northwest Crop Improvement Association; Minnesota, Department of Plant Pathology, R. C. Rose, extension plant pathologist, H. R. Sumner, Northwest Crop Improvement Association; North Dakota, W. E. Brentzel, plant pathologist, and H. R. Sumner, Northwest Crop Improvement Association; Montana, Dr. P. A. Young, botanist; Idaho, Dr. C. W. Hungerford, plant pathologist; Utah, Dr. B. L. Richards, Department of Plant Pathology, and D. C. Tingey, Department of Agronomy.

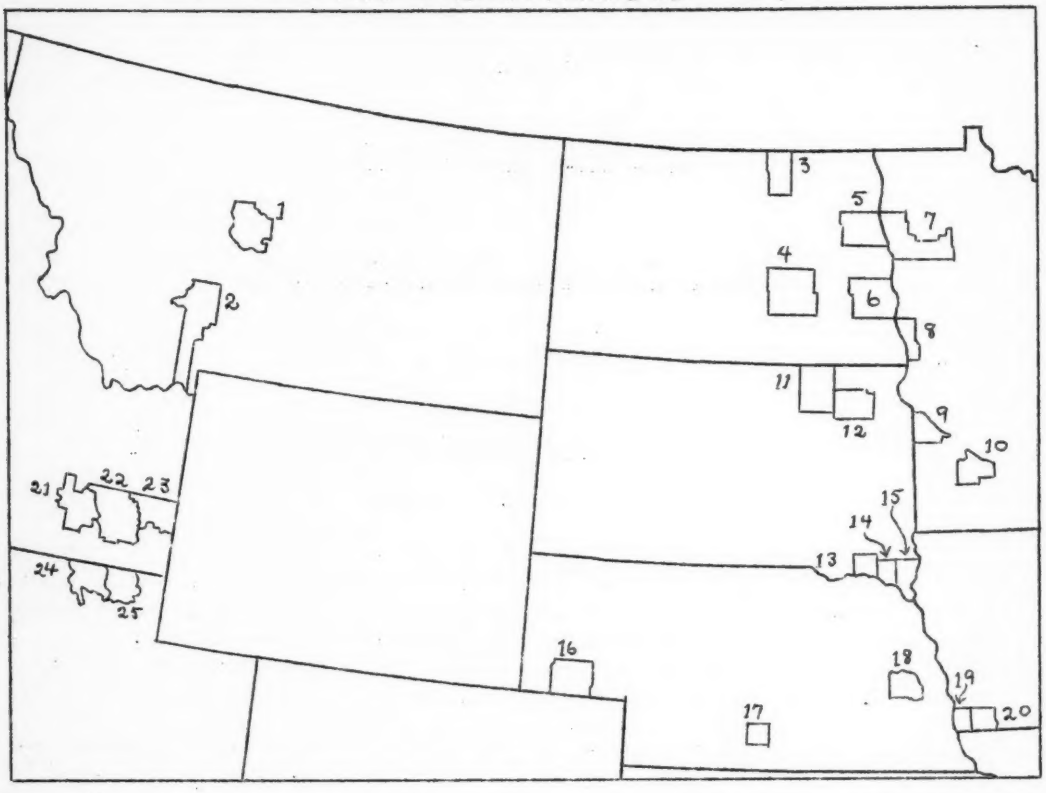

Figure 2. Counties included in the survey for stinking smut of wheat, 1931.

Montana:
1 - Judith Basin
2 - Gallatin

North Dakota:
3 - Towner
4 - Stutsman
5 - Grand Forks
6 - Cass

Minnesota:
7 - Polk
8 - Wilkin
9 - Lac Qui Parle
10 - Redwing

South Dakota:
11 - Brown
12 - Day
13 - Yankton
14 - Clay
15 - Union

Nebraska:
16 - Cheyenne
17 - Phelps
18 - Saunders

Iowa:
19 - Fremont
20 - Page

Idaho:
21 - Caribou
22 - Bannock
23 - Power

Utah:
24 - Box Elder
25 - Cache

OBJECT AND PLAN OF THE SURVEY

As in previous surveys, the object of the survey was to determine as accurately as possible the field losses from stinking smut in this area, to determine the percentage of farmers treating their seed and the methods used, and so far as possible to check the effectiveness of the seed treatment. Forms similar to those in previous surveys were used in recording the data (See Supplement 77, Pages 100 to 101. 1930). The various cooperators visited as many farmers as possible during the preharvest season to determine the percentage of smut in the fields and then secured from the farmer information regarding his methods of treatment. As nearly as possible the same counties which have been surveyed in past years were surveyed again this year. Owing to the severe drought in western North and South Dakota and eastern Montana, it was not possible to secure data from these areas.

SPRING WHEAT

MONTANA: The survey in Montana was confined largely to the Gallatin Valley and Judith Basin area. The results for spring wheat are given in Table 8, which is adapted from a report by Dr. P. A. Young.

Table 8. Seed treatment and the percentage of stinking smut in spring wheat in Montana, 1931.

Seed treatment	Number of reports	Acres of Wheat: Number	Acres of Wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	14	1572	112.2	1.37
18-20 per cent " "	4	545	136.2	4.55
Ceresan	1	60	60.	.10
Formaldehyde	8	429	61.2	.11
Copper sulphate	9	1557	173.	.42
Untreated	34	3053	89.7	13.82
Totals	69	7216		
Weighted percentage smut				6.42

It should be noted that much of the spring wheat of this area is irrigated, and considering this fact the percentage of smut was somewhat higher than had been expected. Several fields were found with as much as 34 per cent infection and the weighted average of infection for the entire area of spring wheat examined, that is, 7216 acres, was 6.42 per cent of smutted heads, while in the 3053 acres of untreated fields the percentage of smut was 13.82 per cent. Judging from the low percentage of smut resulting from treatment with copper sulphate, formaldehyde, and Ceresan, it would seem that smut in spring wheat in Montana is largely seed-borne. Soil infestation probably plays a very minor role, if any, in spring wheat, although there are strong indications that it is an important factor in winter wheat.

NORTH DAKOTA: Intensive surveys were made in Cass, Towner, and Stutsman Counties and reports were received from cooperators in several other Counties. A summary of all of the reports from all of the Counties in North Dakota is given in Table 9.

Table 9. Seed treatment and the percentage of stinking smut in spring wheat in North Dakota, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	2	275	137	-
35 per cent " "	2	120	60	-
20 per cent " "	20	2,290	114	.01
Ceresan	3	190	63	-
Formaldehyde	173	18,445	106	1.38
Untreated	21	1,747	38	2.09
Totals	221	23,067		
Percentage smut				1.71

The percentage of smut in the wheat treated with formaldehyde is probably due to poor methods in treating. Many farmers sprinkle the seed or merely dip it into the solution and take it out before it has had time to kill the smut spores. In this State formaldehyde is used more extensively than in any other area included in the survey. This probably is due to the fact that the moist soil at the time of planting permits the use of formaldehyde-treated seed without the severe injury caused by this solution when the seed is planted in dry soil.

SOUTH DAKOTA: The lack of control in the treated seed as shown in Table 10 is probably largely due to poor methods of treatment. The farmers use mostly a rather ineffective sprinkle method without any attempt to remove the smut balls. Several other reports of use of copper carbonate were sent in, but these were incomplete so that they could not be used.

Table 10. Seed treatment and the percentage of stinking smut in spring wheat in South Dakota, 1931.

Seed treatment	Number of Reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
20 per cent copper carbonate	1	72	72.	-
Formaldehyde	51	3,249	63.7	1.32
Untreated	15	476	32.	1.87

MINNESOTA: Table 11. Seed treatment and the percentage of stinking smut in spring wheat in Minnesota, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
20 per cent copper carbonate	30	926	30.8	1.66
Ceresan	6	210	35.	-
Formaldehyde	64	2,563	40.	1.
Untreated	102	4,009	39.3	2.11

The data for the survey in Minnesota has been summarized by R. C. Rose in a mimeographed report entitled "Why Is Minnesota Wheat So Smutty?"

A summary of this report is quoted below:

"Five county surveys for smut in Minnesota during 1930 and 1931 lead to the conclusion that the high percentage of smutty wheat is due to the following facts.

"1. Marquis, durum and Ceres are the leading varieties and all are susceptible to stinking smut.

"2. The number of wheat growers who treated their seed varied from 32 per cent in one county to 62 per cent in another.

"3. The average success of seed treatment in the surveyed counties varied from 31 per cent to 68 per cent.

"4. Machine treated seed gave most satisfactory results with both formaldehyde and copper carbonate. The formaldehyde spray and the copper carbonate shovel mix methods were the least effective. Most of the wheat farmers who treated their seed did not use machines.

"5. Failure to remove smut balls by proper cleaning of seed before treating often leads to recontamination of the seed."

SUMMARY OF SPRING WHEAT:

Table 12. Summary of the stinking smut of wheat survey for the spring wheat States of Montana, North and South Dakota, and Minnesota.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	16	1,847	115.	1.16
35 " " " "	2	120	60.	-
20 " " " "	55	3,833	70.	1.05
Ceresan	10	460	46.	.01
Formaldehyde	295	24,676	83.	1.22
Copper sulphate	9	1,557	173.	.42
Untreated	172	9,285	54.	5.94

Table 13. Methods of seed treatment and smut percentages in the spring wheat States of Montana, Minnesota, North and South Dakota.

Seed treatment	Method Used	Number of reports	Percentage of Smut
50 per cent copper carbonate	Machine treated	25	.8
	Shovel	1	0
35 " " " "	Machine	7	1.4
20 " " " "	Machine	85	.5
	Shovel	21	1.
Ceresan		25	.2
Formaldehyde	Dipped	28	.32
	Sprinkled	234	1.1
Copper sulphate	Dipped	8	1.1
	Sprinkled	1	.1
Untreated		172	4.4

WINTER WHEAT

SURVEY IN THE CENTRAL WINTER WHEAT STATES OF NEBRASKA SOUTH DAKOTA AND SOUTHWESTERN IOWA

The stinking smut survey of winter wheat in this region was limited to three counties in Nebraska and some counties along the Missouri River in southwestern Iowa and southeastern South Dakota.

NEBRASKA: The survey in Nebraska was carried on rather intensively in Saunders, Phelps, and Cheyenne Counties, and a few reports were secured from Jefferson County. By this distribution it was possible to secure an idea of the stinking smut situation in the eastern part of the State where wheat is grown in rotation with corn and other crops, and very little seed treatment is used. The results are shown in Table 14.

Table 14. Seed treatment and the percentage of stinking smut in winter wheat in Nebraska, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	23	2,175	94.5	.71
20 " " " "	55	11,522	209.4	.83
Formaldehyde	21	3,277	156.	.15
Untreated	94	7,735	82.2	2.63
Total	193	24,709		

SOUTH DAKOTA: In South Dakota a survey was conducted in Yankton, Clay, and Union Counties where winter wheat is grown. The seed treatment situation for control of smut here is about the same as throughout southwestern Iowa and southeastern Nebraska. Even though the seed is not treated the percentage of smut is low, probably because of rotation with other crops. Instead of treating farmers secure clean seed from their neighbors who have smut-free wheat. (Table 15).

Table 15. Seed treatment and the percentage of stinking smut in winter wheat in South Dakota, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
Formaldehyde	3	82	27.1	.44
No treatment	43	2,548	59.2	.30
Totals	46	2,630		

IOWA: A few reports were secured from southwestern Iowa. In this part of the State wheat is usually grown on the river bottoms. Of 21 reports no farmer was found who treated his seed. It is quite likely a more extensive survey would have revealed some seed treatment, but certainly the proportion would have been low. (Table 16).

Table 16. Seed treatment and the percentage of stinking smut in winter wheat in Iowa, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
Untreated	21	475	23.	1.16

SUMMARY OF CENTRAL WINTER WHEAT STATES:

Table 17. Summary of the stinking smut of wheat survey for the Northcentral winter wheat States of Nebraska, South Dakota, and Southwestern Iowa.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	23	2,175	94.5	.71
20 " " " "	55	11,522	209.4	.83
Formaldehyde	24	3,359	140.	.157
Untreated	158	10,658	67.	2.03

Table 18. Methods of seed treatment and smut percentages in the northcentral winter wheat States of Nebraska, South Dakota, and southwestern Iowa.

Seed treatment	Method Used	Number of reports	Percentage of Smut
50 per cent copper carbonate	Machine treated	19	.23
	Shovel	4	1.2
20 " " " "	Machine	51	.5
	Shovel	9	.0
Formaldehyde	Dipped	4	1.5
	Sprinkled and Shovel	20	3.9
Untreated		158	1.8

INTERMOUNTAIN SECTION

The following table (Table 19) is taken from a mimeographed report issued by the Pacific Coast Headquarters of the Federal Grain Supervisor at Portland, Oregon. It shows a general increase in the percentage of cars grading smutty from 24.8 in 1923 to 74.7 in 1929.

Table 19. Smutty hard red winter wheat from the Intermountain Area, based on carlot inspections, years 1923-1929, inclusive.

	1923	1924	1925	1926	1927	1928	1929
Carlot receipts	1,629	1,700	2,496	2,403	2,869	3,610	3,074
Carlots smutty	405	500	1,163	1,185	1,570	1,893	2,297
Per cent smutty	24.8	29.4	46.6	49.3	54.7	52.4	74.7

UTAH: The survey in Utah was confined to Boxelder and Cache Counties. From the data given in Table 20 it will be seen that nearly all farmers treat their seed. Only four of the 111 interviewed did not treat. Copper sulphate was the most popular treatment, followed by 20 per cent copper carbonate and 50 per cent copper carbonate. Since it was found that soil infestation plays a very active part in the percentage of smut in this locality, we can not judge very closely the effects of the seed treatment from the amount of smut in the resulting crop. To take, for example, a rather extreme case, a field was found in which the seed had been thoroughly treated with copper carbonate using a Calkins machine and the farmer seemed to have taken very great care to obtain good seed. Nevertheless, his field had a very high percentage of smut, averaging 62 per cent of all heads smutted. In this case the smut was rather patchy in the field, the heads in some areas being almost completely smutted. These areas of heavy smut seemed to conform to the low swales where moisture was retained longer. The variety was Kanred. The smutted stalks were almost invariably greatly stunted, being half the height of uninfected stalks. Numerous other cases were found where wheat grown alongside a field which had been heavily smutted the previous year had become smutted, although reasonable care had been taken in securing and treating the seed. In a few cases this percentage of smut was clearly decreasing as we got further away from the source. It was apparent that heavily smutted fields were centers for the spread of the smut, especially on the leeward side where the spores were blown over to fallow fields and caused infection in the following crop. This was not always the case and in some valleys the wheat was almost free of smut. Such valleys had been reported in previous seasons to have produced heavily smutted grain. Therefore, it seems likely that a better understanding of the relation of these smutted areas to the spread of the smut in the succeeding crop may be a help in

solving this very serious problem, that is, if we knew the conditions which cause a valley to produce heavily smutted grain one year and to be comparatively free from smut another year, we might find a way to aid in the elimination of the smut from the valley every year.

Table 20. Seed treatment and the percentage of stinking smut in winter wheat in Utah, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	30	7,562	252	2.23
20 " " " "	36	3,312	92	4.78
Formaldehyde	1	65	65	-
Copper sulphate	40	5,731	143.2	.27
Untreated	4	353	88.2	.83

IDAHO: A survey in Idaho was confined largely to the Snake River Valley in the southeastern part of the State. Here again soil infestation is very prevalent, and considerable percentages of smut were secured even when the seed was treated. As will be seen from Table 21, the average percentage of smut was almost as high in the treated seed as in the untreated, and numerous cases were seen where infection in the field was clearly traceable to smutty fields of the previous year. Some farmers had attempted to use smutted seed for planting, trusting to seed treatment without removing the smut balls and in these cases it was always possible to find a considerable percentage of smut in the field. The winter wheat in this intermountain section represents dry land wheat usually sown upon land kept fallow the previous season. Such fallow land serves as a trap for air-borne spores and this no doubt accounts for the heavy percentages of smut found in spite of seed treatment.

Table 21. Seed treatment and the percentage of stinking smut in winter wheat in Idaho, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	12	12,860	1,071.5	2.30
Formaldehyde	13	4,779	367.6	2.39
Copper sulphate	9	2,425	269.4	1.98
Untreated	7	1,290	184.2	2.62

MONTANA: In Montana 50 per cent copper carbonate was the most popular treatment and seems to have given best control. The few cases of 18 per cent copper carbonate showed very high infection which seemed to be due to soil infestation. Where no treatment was used 13.82 per cent of smut occurred (Table 22). This emphasizes the fact noted throughout this inter-mountain survey that, other conditions being equal, the untreated seed shows a higher percentage of smut, that is, seed treatment should be carried out even though soil infestation sometimes causes considerable smut in the crop. Greater care should be taken also in cleaning the grain of smut balls. When a liquid treatment is used this may be done by skimming off the lighter smut balls which come to the surface. The means we have for elimination of the smut balls from the grain in preparation for dry treatment are far from satisfactory. The usual process is to pass wheat intended for seed through the fanning mill once, rarely twice, and then apply the treatment.

Table 22. Seed treatment and the percentage of stinking smut in winter wheat in Montana, 1931.

Seed treatment	Number of reports	Acres of wheat: Number	Acres of wheat: Average per farm	Percentage of Smut
50 per cent copper carbonate	48	6,716	139.9	0.89
18 " " " "	4	362	90.5	21.43
Ceresan	12	773	64.4	1.88
Formaldehyde	19	1,997	105.1	2.31
Copper sulphate	15	1,142	76.1	1.69
Untreated	10	397	39.7	13.82

SUMMARY OF INTERMOUNTAIN SECTION:

Table 23. Methods of seed treatment and smut percentages in the intermountain winter wheat States of Utah, Idaho and Montana.

Seed treatment	Methods Used	Number of reports	Percentage of Smut
50 per cent copper carbonate	Machine treated	77	3.7
	Shovel	3	1.5
20 " " " "	Machine	40	6.7
Formaldehyde	Dipped	13	3.5
	Shovel	20	2.6
Copper sulphate	Dipped	21	1.7
	Shovel	3	1.8
Ceresan		22	.5
Untreated		162	2.1

COMPARISON OF DATA FOR ALL REGIONS SURVEYED

Table 24. Comparison of data for all regions surveyed.

Seed treatment	Number of reports			
	Hard Red Spring	Central Winter	Intermountain Winter	Total
50 per cent copper carbonate	26	23	80	129
35 " " " "	7			7
20 " " " "	106	60	40	206
Ceresan	25		22	47
Formaldehyde	262	24	33	319
Copper sulphate	9		24	33
Untreated	172	158	162	492
				1,233

In a comparison of the data from all the regions surveyed, (Table 24), it is interesting to note that 40 per cent of the farmers did not treat at all. Of those who treated, 17 per cent used 50 per cent copper carbonate, 28 per cent used 20 per cent copper carbonate, 6 per cent used Ceresan, 43 per cent used formaldehyde, and 4.5 per cent used copper sulphate.